

Age and Growth of Yellowtail Snapper from South Florida¹

ALLYN G. JOHNSON

National Marine Fisheries Service
Southeast Fisheries Center, Panama City Laboratory
3500 Delwood Beach Road, Panama City, Florida 32407

Abstract

Age and growth of yellowtail snapper *Ocyurus chrysurus* from south Florida were determined from otolith cross-sections. The oldest fish was 14 years old (443-mm fork length). Mean back-calculated fork lengths of 807 fish ranged from 136 mm at the end of year 1 to 429 mm at the end of year 14. The von Bertalanffy equation for 802 yellowtail snapper aged 10 or less was $L_t = 450.9[1 - e^{-0.279(t+0.355)}]$, where L = fork length (mm) and t = years. The length-weight relationship was $W = 6.13 \times 10^{-5}L^{2.76}$, where W = weight (g).

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The yellowtail snapper *Ocyurus chrysurus* is a reef-association lutjanid that occurs on both sides of the Atlantic Ocean. In the west Atlantic, the species ranges from Massachusetts to Brazil, and it is widespread in the Gulf of Mexico (Briggs 1958). Yellowtail snapper is most abundant around the Antilles and south Florida (Fischer 1979), where it is one of the snappers most desired by the recreational fishermen (Nakamura 1976) and is a valuable commercial species. The Florida commercial landing in 1977 was 367 t, worth 712,000 dollars (Anonymous 1980).

To manage yellowtail snapper stocks, an accurate method of ageing the fish is needed. In previous studies, scales and otoliths were unsuitable for this purpose because their markings were not sufficiently distinct (Piedra 1969; Thompson and Munro 1974). Vertebrae were used by Piedra (1969) to estimate the age and growth of yellowtail snapper in Cuba, but they are difficult to collect and prepare. Length frequencies were used for yellowtail snapper in Jamaica by Thompson and Munro (1974); however, length is not a good estimation of age for this species.

In this study, otoliths of yellowtail snapper were re-examined as ageing-structures. Age, growth rate, and length-weight relation for yellowtail snapper from south Florida are reported herein.

Methods

Two sets of yellowtail snapper samples were collected from commercial fish processors and other sources. Set 1 contained 535 fish and was collected between April 1979 and August 1980 in the area between Miami and the Dry Tortugas. From each of these fish, otoliths (sagittae) were taken, and total length (TL) of each was measured (millimeters). Set 2 contained 803 fish and was collected between April and August 1980 from the Florida Keys. From 286 of these fish, otoliths were taken, sexes were recorded when determinable by gross examination of the gonads, and fork lengths (FL) were recorded (millimeters). For 517 fish, fork length and total weight (grams) were measured. Total lengths were measured for 100 of the 517 fish in order to develop a TL-FL conversion. All otoliths were stored dry.

Whole otoliths were immersed in glycerin within a black-bottom watchglass and examined in reflected light at 18× magnification. The total dorsoventral width across the center of the otolith core was measured and the number of opaque bands (lighter-colored than surrounding materials in reflected light, darker in transmitted light) were determined for 218 otoliths (representative subsamples of the length range

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of the fish collected). These otoliths, plus 589 others, then were sectioned through the core in the dorsoventral plane with an Isomet² low-speed saw by the methods of Berry et al. (1977). The sections, 0.18 mm thick, were mounted with Piccolyte cement on glass slides and examined with transmitted light via closed-circuit television at 31× magnification. The opaque (dark) bands were counted, and their distances from the core were measured, along the short (dorsal) arm of the otolith section, designated "otolith radius." The condition (opaque or translucent) of the margin of each section was noted. Sections were read by two people. Total fish lengths were converted to fork lengths, and these were related to otolith dimensions by least-squares methods. A computer program by Abramson (1971) was used to fit the von Bertalanffy theoretical growth curve to the data.

Results and Discussion

Under reflected light, patterns of weak, alternating opaque (light) and translucent (dark) bands were visible on concave surfaces of whole otoliths. These bands seemed clearer than implied by Piedra (1969), and could be counted. Nonetheless, 9% of the otoliths had more bands in cross-section than were apparent on the surface, perhaps due to increases in thickness and curvature of the otoliths as fish grew. Beamish (1979) reported a similar phenomenon in otoliths of the Pacific hake *Merluccius productus*. For this reason, only the interior structure of the otolith was used to age yellowtail snapper in this study. In transmitted light, cross-sections showed thin opaque (dark) bands separated by thicker translucent bands (Fig. 1).

Opaque margins were found only on otoliths from fish collected in late spring (April–June). The percentages of otoliths with opaque margins were: Set 1—April 8.6, May 39.2, and June 15.9; Set 2—May 9.0 and June 31.6. The mean widths of the translucent margins were least during May–July, indicating that opaque bands were recently completed and deposition of translucent material had resumed (Fig. 2). The opaque bands thus were considered to be annular deposits. The peak spawning period of

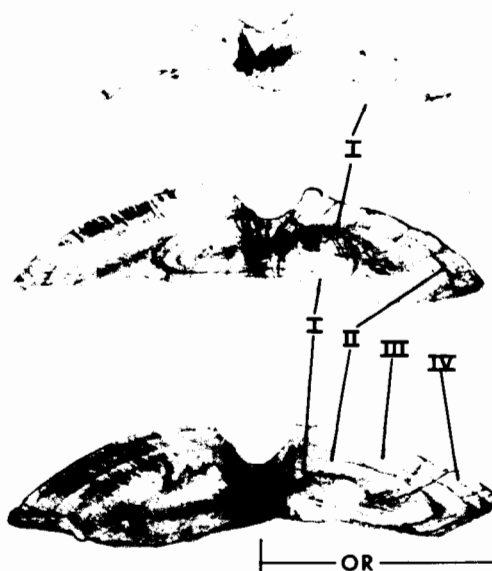


FIGURE 1.—Otolith cross-sections from yellowtail snapper viewed in transmitted light. Annuli I–IV are marked for (top to bottom) 1-, 2-, and 4-year-old fish (fork lengths 228, 256, and 355 mm, respectively). OR = otolith radius from core to dorsal edge.

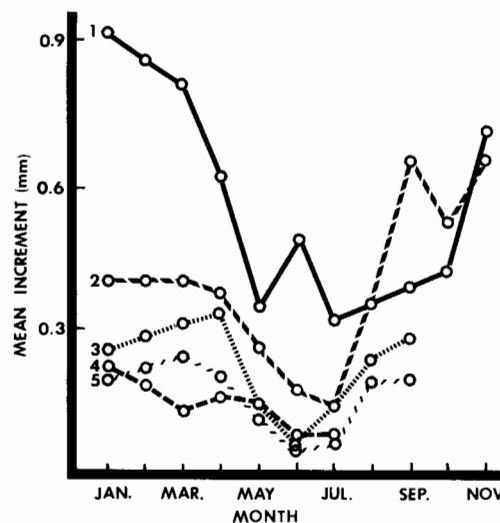


FIGURE 2.—Mean widths of translucent marginal material on yellowtail snapper otoliths formed since the last deposition of an opaque band, related to time. Separate curves are given for otoliths with one, two, three, four, and five opaque bands.

² Reference to trade names in this publication does not imply endorsement of commercial products by the National Marine Fisheries Service, NOAA.

TABLE 1.—Mean back-calculated fork lengths (mm) at age for yellowtail snapper from south Florida.

| Age group | N | Length at capture | | Annulus | | | | | | | | | | | | | |
|--------------------------|-----|----------------------|------------------|---------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| | | Range | Mean \pm SD | | | | | | | | | | | | | | |
| | | | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 |
| <i>Males</i> | | | | | | | | | | | | | | | | | |
| I | 9 | 198-249 | 229 \pm 15 | 171 | | | | | | | | | | | | | |
| II | 62 | 124-311 | 251 \pm 29 | 136 | 230 | | | | | | | | | | | | |
| III | 50 | 235-359 | 282 \pm 30 | 137 | 228 | 268 | | | | | | | | | | | |
| IV | 18 | 275-418 | 326 \pm 40 | 158 | 242 | 284 | 311 | | | | | | | | | | |
| V | 11 | 310-362 | 329 \pm 18 | 152 | 232 | 269 | 296 | 316 | | | | | | | | | |
| VI | 3 | 368-382 | 373 \pm 8 | 174 | 256 | 295 | 324 | 338 | 363 | | | | | | | | |
| VII | 1 | | 354 | 135 | 210 | 256 | 284 | 217 | 335 | 349 | | | | | | | |
| VIII | 1 | | 454 | 222 | 288 | 343 | 388 | 404 | 426 | 437 | 449 | | | | | | |
| IX | 0 | | | | | | | | | | | | | | | | |
| X | 0 | | | | | | | | | | | | | | | | |
| XI | 0 | | | | | | | | | | | | | | | | |
| XII | 1 | | 468 | 183 | 242 | 281 | 308 | 332 | 359 | 374 | 390 | 406 | 421 | 441 | 452 | | |
| Weighted mean | | | | 144 | 232 | 273 | 309 | 326 | 368 | 387 | 419 | 406 | 421 | 441 | 452 | | |
| N | | | | 156 | 147 | 85 | 35 | 17 | 6 | 3 | 1 | 1 | 1 | 1 | 1 | | |
| Annual incre- ment | | | | 144 | 88 | 42 | 35 | 17 | 52 | 19 | 32 | -14 | 16 | 20 | 12 | | |
| <i>Females</i> | | | | | | | | | | | | | | | | | |
| I | 9 | 205-316 | 247 \pm 35 | 189 | | | | | | | | | | | | | |
| II | 36 | 206-315 | 256 \pm 25 | 136 | 232 | | | | | | | | | | | | |
| III | 26 | 219-365 | 292 \pm 34 | 132 | 234 | 277 | | | | | | | | | | | |
| IV | 17 | 236-401 | 320 \pm 78 | 157 | 240 | 283 | 311 | | | | | | | | | | |
| V | 6 | 296-367 | 331 \pm 27 | 130 | 230 | 264 | 297 | 318 | | | | | | | | | |
| VI | 1 | | 422 | 182 | 275 | 329 | 358 | 393 | 417 | | | | | | | | |
| VII | 0 | | | | | | | | | | | | | | | | |
| VIII | 1 | | 450 | 120 | 215 | 278 | 326 | 373 | 407 | 426 | 445 | | | | | | |
| Weighted mean | | | | 143 | 234 | 279 | 310 | 334 | 412 | 426 | 445 | | | | | | |
| N | | | | 96 | 87 | 51 | 25 | 8 | 2 | 1 | 1 | | | | | | |
| Annual incre- ment | | | | 143 | 91 | 44 | 31 | 24 | 78* | 14 | 19 | | | | | | |
| <i>All fish</i> | | | | | | | | | | | | | | | | | |
| I | 77 | 172-462 | 222 \pm 38 | 148 | | | | | | | | | | | | | |
| II | 243 | 124-374 | 256 \pm 29 | 125 | 221 | | | | | | | | | | | | |
| III | 190 | 219-462 | 292 \pm 33 | 132 | 225 | 269 | | | | | | | | | | | |
| IV | 133 | 236-451 | 334 \pm 40 | 143 | 232 | 281 | 314 | | | | | | | | | | |
| V | 92 | 275-492 | 355 \pm 45 | 145 | 233 | 281 | 313 | 338 | | | | | | | | | |
| VI | 30 | 336-509 | 386 \pm 27 | 150 | 251 | 295 | 326 | 352 | 373 | | | | | | | | |
| VII | 10 | 291-520 | 373 \pm 93 | 126 | 225 | 266 | 294 | 323 | 343 | 360 | | | | | | | |
| VIII | 12 | 432-518 | 445 \pm 10 | 149 | 244 | 301 | 338 | 370 | 396 | 416 | 432 | | | | | | |
| IX | 10 | 425-555 | 453 \pm 34 | 150 | 240 | 288 | 324 | 354 | 382 | 403 | 423 | 440 | | | | | |
| X | 5 | 346-530 | 458 \pm 69 | 111 | 201 | 246 | 274 | 302 | 332 | 360 | 379 | 393 | 411 | | | | |
| XI | 2 | 472-520 | 496 \pm 34 | 114 | 213 | 256 | 289 | 314 | 356 | 382 | 398 | 415 | 448 | 443 | | | |
| XII | 2 | 468-567 | 518 \pm 70 | 176 | 259 | 308 | 345 | 376 | 403 | 418 | 433 | 448 | 462 | 477 | 487 | | |
| XIV | 1 | | 443 | 176 | 242 | 271 | 281 | 292 | 309 | 323 | 337 | 358 | 373 | 383 | 401 | 418 | 429 |
| Weighted mean | | | | 136 | 227 | 277 | 315 | 342 | 371 | 389 | 416 | 422 | 422 | 445 | 458 | 418 | 319 |
| N | | | | 807 | 730 | 487 | 297 | 164 | 72 | 42 | 32 | 20 | 10 | 5 | 3 | 1 | 1 |
| Annual incre- ment | | | | 136 | 92 | 50 | 38 | 27 | 29 | 19 | 26 | 7 | 0 | 23 | 14 | -40 | 10 |

* Unrealistically high value probably caused by small number of samples.

yellowtail snapper in the Florida keys and the western end of Cuba is May–July (Piedra 1969; L. A. Collins, National Marine Fisheries Service, Panama City, Florida, personal communication). The process of spawning may be the cause of opaque-band formation. The agreement between two readings of the numbers of opaque bands on each otolith cross-section by one investigator was 97% and agreement between readings by two investigators was 95%.

Total fish lengths were converted to fork lengths by $FL = 17.7 + 0.78TL$; $r = 0.97$. The relationship between fork length and otolith radius OR was $FL = 35.88 + 7.55OR$; $N = 286$; $r = 0.76$. This equation was used for back-calculation of size at age. The relationship between fork length and whole-otolith width H was $FL = -2.82 + 3.95H$; $N = 218$; $r = 0.98$. The higher correlation for whole otoliths suggests that some of the variation in the FL – OR relation is the result of sectioning and the slightly scalloped margin of the otoliths.

Yellowtail snapper are long-lived, reaching at least age 14 (Table 1). The length of yellowtail snapper at time of capture varied greatly within a given age group. For example, fish with four annuli ranged in fork length from 235 to 451 mm (Table 1); thus, fish length is a poor indicator of age for this species. This type of variation is not unusual in fish from south United States waters; king mackerel *Scomberomorus cavalla*, Spanish mackerel *Scomberomorus maculatus*, red grouper *Epinephelus morio*, sailfish *Istiophorus platypterus*, and black sea bass *Centropristis striata* have large variation in size within age groups (Beaumariage 1973; Powell 1975; Moe 1969; Jolley 1977; Waltz et al. 1979, respectively).

Back-calculated size at age for males and females were similar for fish younger than 5 years. Females may be larger than males at older ages but sample sizes were too small to confirm this. These yellowtail snapper from south Florida were larger at age than Piedra's (1969) from Cuba. The differences may be the result of geographical variation in growth rates, gear selectivity, levels of exploitation, et cetera.

Back-calculated mean lengths (weighted) for all fish aged I–X were fitted to the von Bertalanffy growth model, which resulted in $L_t = 450.9[1 - e^{-0.279(t + 0.355)}]$; where L = fork length (mm) and t = time (years). Growth rate, as indicated by the K value 0.279, is similar to those

found for other reef-fish species (Pauly 1978; Manooch 1979, 1982). The higher K values of some members in the reef-fish group have been associated with differences in feeding habits (Grimes 1978). The yellowtail snapper's K value and its food preferences of zooplankton and shrimp (Randall 1967) may be considered as additional support to the Grime's hypothesis of higher K values for species feeding on lower trophic levels. The higher-trophic-level fish (benthic predators) have K values around 0.1 (see Ross and Huntsman 1982 for additional references).

The relationship ($r = 0.97$) between fork length (mm) and weight W (g) of 517 yellowtail snapper ranging from 100 to 500 mm FL was $W = 6.13 \times 10^{-5} FL^{2.76}$. The weights predicted from this equation agree reasonably well with those generated by both Thompson and Munro (1974) and Piedra (1969) within the sampled size ranges. The equations of these workers predicted heavier fish than mine for lengths greater than 500 mm FL. None of the equations were developed from fish larger than 500 mm; thus, these differences could be artifacts of extrapolation.

The use of otolith cross-sections is a promising method for determining age and growth parameters of yellowtail snapper populations. Future growth studies for this species should emphasize older fish and geographical variations.

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